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APPLICATION OF QUANTITATIVE STATISTICS IN FISHERIES RESEARCH

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In every walk of life, there is a need for statistical data. After the discovery of fire and wheel, man's quest for knowledge started. He explored the nature and gathered information and learnt to utilize the facts and figures for taking decisions. No field of study is complete without quantitative data and its analysis to put forth the theories or conclusions evolved. For example, in planning the economy of the country, good statistical data on the available resources, returns is needed for fixing the production targets, allocating funds and laying out the policies. While the words statistics" and "data" are often used interchangeably by the public, statistics actually goes far beyond the mere accumulation of data.

Data means a series of measurements or observations—usually in numerical form, of some phenomenon. On the other hand, the word "statistics" refers to an academic discipline and a set of best practices to convert data into meaningful, actionable information about the real world, particularly in the presence of uncertainty. The word "statistic" is also used in the specialist literature to mean "a numerical summary of data."

Statistics is extensively employed in many real-world measuring processes. It has wide applications in any branch of science or research viz., agriculture, meteorology, oceanography, forestry, fisheries, animal husbandry, geology, epidemiology, medicine, communication, visualization, education, politics, psychology, atomic physics, space research, climate change studies, economics and governance.

Indian fisheries

Indian fisheries sector has come a long way since independence with annual production levels of over 11.78 million tonnes of fish and shellfish from capture fisheries and aquaculture

Data generation in fisheries

Fisheries sector undergoes continuous changes with the introduction of new technologies evolved through R & D institutions. Validation of these technologies and providing inputs for needs of the sector is one of the important mandates of Statisticians. Statistics per se deals with generation of data, data management, data analysis and information generation from data. The data needs in fisheries will vary according to the type of research. A biologist who

works on species behavior, growth, abundance, etc. will require information on the spatial distribution and catch. Likewise, an economist who wishes to predict next year's profit should understand the effect of population size on producer's costs.

Policy makers may need macro level data on infrastructure, employment, earnings, investment etc. to formulate management measures. Data on marine fisheries gets generated from the operation of commercial fishing vessels and research vessels. In 'Fishery technology' large volumes of data generated in a wide range of applied scientific areas of fishing technology, fish processing, quality control, fishery economics, marketing and management. Apart from statistical data collected in technological research, data also collected on production, export, socio-economics etc. for administrative and management decision making. Major areas of data generation:

- fishing vessel and gear designs
- fishing methods
- craft and gear materials
- craft and gear preservation methods
- fishing efficiency studies
- fishing accessories
- emerging areas include use of GIS and remote sensing

Data on various aspects of fishing gets collected for administrative purposes and policy making. For administrative purposes, voluminous data gets generated through fisheries departments of states. Each district has officials entrusted with the work of collection of data which are coordinated at the state level. State level figures are compiled at the National level by Department of Animal Husbandry and Dairying, Ministry of Agriculture, New Delhi. Information is also compiled on macro-economic variables like GSDP from fishing by the respective Directorates of Economics & Statistics.

Fish production statistics

Indian fisheries have seen tremendous development over the past six decades owing to technology changes in fishing like mechanization of propulsion, gear and handling, introduction of synthetic gear materials, development of acoustic fish finding devices, satellite based fish detection techniques, advances in electronic navigation and communication equipment. The increase in fish production can be said as exponential with a mere 75000 MT in 1950-51 to 11.42 million MT in the current year. Both marine fisheries and aquaculture have contributed to the present level of production with share from culture fisheries more than the capture fisheries. It is important task to collect macro level data from state and country on fish production and details of the species caught in the sea. The data on fish catch and effort (a measure of fishing activity of vessels at sea), from all the coastal states, Union territories, Islands is being done by ICAR-Central Marine Fisheries Research institute and maintained as

database. Based on standard sampling methodology developed by CMFRI, daily data on commercial landings from selected centres/zones all over the coast is collected, compiled and published. Detailed time series data has been generated on species wise, region wise, gear wise fish landings are collected and compiled for the use of researchers and policy makers. The beach price of fish (species wise) is also collected periodically.

Data on fish farms, production and area under aquaculture is maintained by the respective State Fisheries departments and compiled at the National level. Apart from capture fisheries (marine) and culture fisheries (aquaculture) the fish production from inland water bodies like lake, ponds, reservoirs, etc. is collected and compiled at State level. For developing the sector, various programmes and projects have to be formulated and implemented. To achieve the objectives of such developmental programmes, the current status of production of fish from various regions has to be made known. The need for fish production data maintained by these agencies from marine sources, aquaculture and inland water bodies arises while formulating various research studies and development projects at district, state and National level.

Quantitative statistics on fish exports

Fresh fish after harvest is iced and distributed through various channels into the domestic markets and overseas markets. Around 80% of the fish is marketed fresh, 12% of fish gets processed for the export sector, 5% is sent for drying/curing and the rest is utilized for other purposes. Marine Products Export Development Authority (MPEDA) maintains the database on export of fish and fishery products from India to various country. The weekly prices realized by Indian seafood products in the various overseas markets are also collected and compiled by the agency. Marine Products Export Development Authority (MPEDA) established in 1972 under the Ministry of Commerce responsible for collecting data regarding production and exports, apart from formulating and implementing export promotion strategies. Prior to the establishment of MPEDA, Export Promotion Council of India was undertaking this task. Fish processing factories established all over the country generate data on daily production, procurement of raw material and movement of price structure etc. which is generally kept confidential. Data on quality aspects maintained by Export Inspection Council of India through Export Inspection Agency (EIA) in each region, under Ministry of Commerce and Industry. The EIA is the agency approving the suitability of the products for export

- bacteriological organisms present in the products
- rejections in terms of quantity
- reason for rejection etc.

Quantitative statistics on fish quality control

Other types of data generated by CIFT in fishing and fish processing technology are quality control data on fish and fishery products, ice, water, etc. Offshoot of processing technology is Quality Control of which Statistical Quality Control forms an integral part. Due to the stringent

quality control measures imposed by importing countries, especially the EU and USFDA standards samples of fish and related products like raw materials, ice and water samples and swabs from fish processing factories are tested at the quality control labs. Another area where statistics gets generated is in product development: consumer acceptability and preference studies mainly for value-added products. Using statistical sensory evaluation methods this data gets analysed.

At Central Institute of Fisheries Technology (CIFT) we are periodically collecting data on the following aspects which is used for policy decisions

Techno-economic data on various technologies developed

♣ Data on Economics of operation of mechanized, motorized and traditional crafts

♣ Data for the estimation of fuel utilization by the fishing industry

♣ Year wise data on Installed capacity utilization in the Indian seafood processing industry

♣ Demand – supply and forecast studies on the fishing webs

♣ Harvest and post-harvest losses in fisheries

♣ Transportation of fresh fish and utilization of trash fish

♣ Impact of major trade policies like impact of anti-dumping, trend analysis of price movement of marine products in the export markets

♣ Study on impact of technology and study on socio-economic aspects

Quantitative estimation of Fish losses in harvest and post-harvest sector Loss per se is defined as the quantity of marine fish which is not fit for human consumption due to physical loss or spoilage of some other reason. Losses at the time of harvesting and onboard the fishing craft are called harvest losses and losses occurring after harvesting i.e. from the landing centre up to the consumer at different stages are called postharvest losses. Post-harvest losses occur due to improper handling and lack of infrastructure at different points starting from the landing centre to the consumer. Apart from these, there are latent losses such as realization of low value due to glut, multi-day fishing etc.

Discarding takes place because, in the course of fishing, many species other than the target species are often caught. This by-catch is usually discarded at sea unless it is worth keeping. Discarding by-catch consisting of a small proportion of mature specimens from healthy stocks causes relatively little damage, but when it consists of juveniles of commercial species it will disturb the balance of the system. Catching large numbers of juveniles is likely to reduce the future number of mature fish. This will have a direct impact on the fishery taking the by-catch, or on other fisheries if the juveniles belong to their target species.

A recent study completed at CIFT, Cochin attempted to estimate harvest and post-harvest losses in marine fisheries. Ernakulam and Alleppey districts were covered for the study. The estimation was carried out at the two stages harvest and post-harvest stages using stratified random sampling design. The channels of fish production namely mechanised, motorised and

traditional formed the various strata at the harvest stage. In the post-harvest stage, losses occurring at landing centre, processing, marketing and transportation sectors were observed. The study was conducted for a full fishing season to observe loss pattern during monsoon, pre-monsoon and post-monsoon seasons.

Harvest losses in marine fisheries was estimated from Ernakulam district by stratifying fishing crafts into mechanized, motorized and traditional. Primary data on fish catch and losses was collected for 12 months from fishing crafts operating in six selected fish landing centres at Ernakulam. Loss estimates were computed analysing the season wise data and pooled data.

Multiday fishing by the mechanized trawlers reported maximum loss due to capture of juveniles and their discards. Around 1500 to 2750 kg of fish gets discarded at sea by trawlers during fishing trips for more than 7 days' duration. The no. of hauls during fishing and loss was positively correlated (0.69) at 5% level of significance. The estimate of loss due to mechanized fishing was computed by utilizing information on no. of hauls which was more precise than the traditional estimator. The losses due to motorized fishing crafts was very less in comparison with trawlers. The traditional fisheries sector reported minimal or no loss during the period.

The reasons for post-harvest losses in fisheries are summarised below:

Type of Post-harvest loss	Reasons
Loss in nutritional value (1. Unfit for human consumption 2. Product is unattractive and rejected by consumer)	High temperature, washing in polluted water, poor handling, poor storage
Physical loss (1. Thrown away 2.Loss of material due to damage)	It may be a bycatch not intended for capture, not worth marketing due to low price realization, poor packaging, rough handling
Quality loss (Deterioration in quality)	Most common of PH loss- Must have undergone changes due to spoilage or mishandling, marketed several hours after catching without proper icing
Loss due to market forces (Economic loss)	Inadequacy between demand and supply - Bulk landing of same species by subsequent boats in the same day
Losses due to traditional	Sun-dried, processed smoked fish, salting

processing	prone to quality losses
Losses at Transportation, storage	Improper packaging which triggers spoilage, spillage, insufficient icing, rough handling
Loss due to insect infestation	Infestation in sun dried products

Quantitative techniques for evaluating consumer preferences

The emerging fast-food culture among the young and affordable has brought focus on processed food and its demand in the domestic food market in India. Domestically, spending on food and food products constitutes the largest portion of the Indian consumer's spending – more than a 31% share of wallet. Evaluation of consumer preferences before introducing a new product will help the marketer to refine the product for better reach. Conjoint analysis is a popular technique used in marketing research to study the features a product should possess to have a wide consumer reach. Conjoint analysis was initially conceptualized by Luce and Tukey (1964) and further developed by Green and Rao (1971) for marketing research. It employs a decompositional method to estimate the structure of consumer preferences and consumer utility values of different attributes of a product or service. It is a decompositional method that

disaggregates the structure of consumer preferences into utility values. The relative importance of a product can also be estimated using this method. Conjoint analysis assumes that consumers make purchases by simultaneously considering several attributes of a product. The ability to analyze several attributes at once distinguishes conjoint analysis from traditional market research methods where each attribute is studied separately. Usually, conjoint analysis consists of a main-effects analysis of variance with ordinally scaled dependent variables. Consumer preferences are the dependent variables, and product attributes are the independent variables. The following are some of the questions that can be answered with a conjoint analysis

- How important is each product attribute to consumers?
- Which existing products do consumers prefer?
- What combination of product attributes do consumers prefer most?
- How well will my product do in the current market?

Subjects provide data about their preferences for hypothetical products defined by attribute combinations. Conjoint analysis decomposes the judgment data into components, based on qualitative attributes of the products. A numerical part-worth utility value is computed for each level of each attribute. Large part-worth utilities are assigned to the most preferred levels, and

small part-worth utilities are assigned to the least preferred levels. The attributes with the largest part-worth utility range are considered the most important in predicting preference

Big data

Big data and analytics can play a major role in Enterprise Information Management. Globally, the volume of available data in all the sectors has continued to double every three years as information pours in from transactions, social media, sensors in the physical world, and billions of mobile phones. Data storage capacity has increased, while its cost has plummeted. Data scientists now have unprecedented computing power at their disposal, and they are devising ever more sophisticated algorithms that can instantly sift through troves of data to find patterns and reveal insights. The upshot of all this innovation is that decisions no longer have to be based on gut instinct, or subject to human error. Algorithms can make them instantly and consistently, drawing on a mountain of evidence. Systems enabled by machine learning can provide customerservice, manage logistics, analyse medical records, or even write news stories.

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